WEED CONTROL SYSTEMS FOR UPLAND RICE PRODUCTION

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INTRODUCTION

Nearly one-quarter of the total rice area of the world is planted to upland rice (10). At least two-thirds of the production in Latin America and West Africa is from upland culture (3,36). Probably 30-40 percent of the rice in the world is grown following dry soil preparation (23).

Much of the upland rice in West Africa is grown on small farms under shifting cultivation. With this system, the farmer clears the underbrush towards the end of the dry season leaving the large trees of economic value intact (18). Generally the stumps and roots from which the forest regenerates are left in the ground (13). The underbrush is allowed to dry and is then burnt. After the commencement of the rains, the farmer sows his crop of rice which may be mixed with other crop seeds using a hoe with which he scratches the surface soil to cover the seeds (18). Farms rarely exceed 1 hectare in size mainly because the farmer is unable to weed a larger area.

Introduction of mechanization to this system would not be feasible due to the poor method of clearing, the small size of the farms and the cropping pattern.

Yields of upland rice are low because of problems such as lack of suitable varieties, erratic water supply, and poor weed control. In West Africa, once land clearing has been accomplished weeds are recognized as the number one problem (36). Dadey (9) notes that protecting the rice crop from weed infestation is one of the most important and effective yield-increasing operations. In the absence of efficient weed control, other inputs such as high-yielding, disease and insect resistant varieties, fertilizers and water control will be useless (9).

A yield increase of only 15 percent would reduce by 50 percent the amount of rice imported annually into West Africa (9) but unfortunately farmers do not always see that well timed weed control is important (17) and weeding if practiced in these countries is late and inefficient (1). In Sierra Leone, in 1971, there was an almost total loss in yield on a 25 hectare upland rice farm due to a 3-week delay in weeding (29).

One hand weeding no matter how properly timed will not provide season long weed control in upland rice (29,30). Renaut (30) suggests an initial weeding as early as possible followed by a second weeding about 30 days later. In the Western State of Nigeria, it is recommended that the first weeding be done 2-3 weeks after planting followed by a second weeding 3-4 weeks later and by a third if necessary (26). Unfortunately in this area many of the farmers weed only once. They give shortage of labor and lack of money as reasons (39).

Methods of weed control during crop growth

The major farm operation during the growing season regardless of the country or the method of production is weed control. Le Moigne (21) regards weeding as the major bottleneck in the rice agricultural calendar.

Indirect methods

1. Dadey (9) states that only about 10 percent of the rice crop is planted into reasonably clean seedbeds. In order for rice to be able to compete successfully against weeds it must be planted into a weed-free seedbed.

Nicou and Poulain (25) observe that good plowing can remove the need for one or two hoeings and Curfs (pers. comm.) has found less weed growth on soils that have been plowed to a depth of 25 cm or rotovated than those that have been shallow plowed or not tilled. However, Sealy (pers. comm.) said that despite good land preparation on a 250 hectare rice farm in Nigeria weeds became the major limiting factor to high yields.

Parry (27) suggests that the land should be plowed once but harrowed at least twice before it can attain the tilth which is desirable for rice growing and both oxen (25) and tractors (Sealy, pers. comm.) have been used successfully.

2. Contamination of crop seed with weed seed is the most serious means of weed spread. Clean seed must be provided to or used by the farmer. This is especially so where the weed and the crop are closely related species as in West Africa with wild and cultivated rice (4).

3. Sowing of upland rice by broadcasting is widely practiced delaying weeding (7) and making it difficult and expensive (9). In fact, it is almost impossible to control weeds satisfactorily without herbicides if rice seeds have been broadcast (1). The most effective way of reducing the burden of weeding would be to sow all crops in rows (34).

4. Closer row spacing would increase the competitive ability of the crop but virtually exclude anything but herbicides as a means of weed control.

5. The stale-seedbed technique involves using a contact non-residual herbicide about 3 weeks after land preparation to kill emerged weeds. The crop is then planted with minimum disturbance of the soil. Later weedings may be reduced or delayed using this method (30).

Direct Methods

(a) Handweeding

Hand weeding is the most common method of weed control in upland rice. It is an effective means of weed control but it is tedious (2), time consuming (2,11) and requires much labor (11,24). Labor is expensive (12,24) and at times in short supply (17) either because it cannot meet the high requirement at a given time or because it is permanently inadequate (17). In addition by the time weeds have reached the stage when they can be removed by hand, they have competed with the crop and reduced yields (6). At IITA, in an upland rice field heavily infested with weeds, 244 man-hours were required for one hand

weeding 14 days after seeding. A one week delay in weeding increased the time required to weed by more than 40 man-hours. The time required to carry out 3 hand weedings, 2, 5 and 8 weeks after planting, was 70 hours higher than that required to do 2 hand weedings, 3 and 6 weeks after planting (Curfs, pers. comm.).

(b) Hoe weeding

Hoe weeding has many of the disadvantages of hand weeding. It is, however, a faster operation (approximately twice as fast - Curfs, pers. comm.), it can be carried out at an earlier stage in the growth cycle of the crop, and is more thorough when weeds within the row are removed by hand at the same time. In addition it has proved superior to other mechanical methods of weed control (18). Both hand and hoe weeding are suitable only for use on small farms. Other methods of weed control must be used on larger areas.

(c) Interrow cultivation

In Fiji, interrow cultivation by horse-drawn equipment has been used successfully for weed control in upland rice planted at wide row spacings (28) but in Madagascar attempts to use animal-drawn equipment have not succeeded (21). In West Africa, both in Ivory Coast (30) and Nigeria (15), attempts to control weeds by interrow cultivation have failed.

Uprooting or severe damage of the rice plants will occur if cultivation is carried out too close to the rice row. Thus weeds within and close to the row are not controlled and these are the most deleterious with regard to weed competition. Renaut (30) states that any weeding achieved by this means would be virtually ineffective.

(d) Herbicides

Considering the problems associated with other methods of weed control, herbicides may offer the most practical, effective and economical means of reducing weed competition, crop losses and production costs in upland rice. They may be the only method of weed control suitable for large scale rice production.

At present, little or no chemical weed control is practiced in this crop. The compounds available are either (i) unsuitable due to lack of persistence (1,8) or have a deleterious effect on the rice (1,8) or (ii) too expensive (3,4,7,8, 36). De Datta et al (10) have shown that suitable compounds are available and herbicide usage is economically feasible if improved varieties are grown under optimum cultural practices.

One of the main advantages of herbicide treatments are that they are rapid. They can be applied either before crop and weed emergence so that their residual effect will last until the critical period of weed competition has passed or postemergence when the weeds start competing with the crop.

In South-Western Nigeria, rice is probably the only arable crop grown as a sole crop (35) but in many shifting cultivation areas, in order to reduce weed control problems and to maximize land usage, upland rice is often grown in association with other crops. Unless crop association are simple, herbicides will be impossible to use in such a system (22). Herbicides, therefore, must

be evaluated for their possible effects on other crops grown in association with upland rice (37).

Possible herbicides for weed control in upland rice

1. Hormones

In shifting cultivation areas, where broadleaf weeds predominate the weed flora soon after clearing the forest, 2,4-D has given effective results (31). With continued cultivation, the weed population soon becomes dominated by grasses (5,22) and this compound is no longer effective. MCPA and 2,4-D have been used for weed control in upland rice in Fiji (6) and promising results have been obtained with MCPA in Indonesia (19).

2. Butachlor

Butachlor is recommended for use at 2 kg/ha in the Philippines (10) but phytotoxicity when the compound is applied soon after seeding has been reported (13,15). In West Africa, it has failed to give sustained weed control (2,30).

3. Propanil

This has probably been the most widely tested compound for weed control in upland rice. Effective weed control with a single application has been achieved in many areas (6,10,14,19,24,28). However, propanil is a contact herbicide and many (2,10,20,30) report a single application to be unsatisfactory. Sequential treatments approximately 3 weeks apart on predominately grass populations will probably give better results but such treatments may make the cost prohibitive (20).

4. Fluorodifen

Good results with this compound have been observed in Nigeria (15), and the Philippines (10,11) but it has performed poorly in Ghana (2) and New Guinea (6).

5. Mixtures

At present, herbicide combinations seem to offer the best possibility for achieving successful weed control in upland rice.

A combination of propanil applied early postemergence followed by 2,4,5-T performed significantly better than either propanil or 2,4,5-T alone and was more effective than hand weeding in Central America (32). Propanil and MCPA applied sequentially have been effective in Indonesia (33) and propanil followed by 2,4-D plus MCPA looked good in the Ivory Coast except where grass re-invasion occurred (30). However, plots treated with propanil followed by 2,4-D yielded less than 50% of the weeded control plots in the Philippines (38).

A butachlor-propanil mixture has given good results in West Africa (14,15,30) as has propanil-dichlobenil in the Ivory Coast (30).

Fluorodifen followed by propanil has performed well at IITA (14,15) while a combination of the two has performed consistently well in the Ivory Coast (30). Even better results were obtained with preemergence applications of avirosan,

melsan, Mowdown or A 70-25 followed by a postemergence application of propanil (16). None of these compounds when tested alone gave satisfactory weed control.

CONCLUSIONS

Weeds are one of the major limiting factors of upland rice production throughout the world. Average yield losses due to uncontrolled weed growth range from 40 to 85 percent and in some instances complete loss has occurred. Present control methods are unsuitable for continuous or large scale farming. Unless alternative methods are found upland rice production will be confined to small scale operations. In shifting cultivation areas, once weeds become too great a problem the land will be abandoned to forest,a cheap and effective means of weed control.

Extensive research needs to be done to find alternatives to the methods presently being used. Herbicides, probably in combinations, offer the greatest possibility to replacing the present system. Highest priority should be given to research that is aimed at finding chemicals that are economical and effective. In addition, there is an urgent need to train people in practical aspects of weed science so that they can carry out the research so desperately needed and help disseminate the information found to the farmer.

LITERATURE CITED

1. Abifarin, A.O., Chabrolin, R., Jacquot, M., Marie, R., and Moomaw, J.C. 1972. Upland rice improvement in West Africa. p. 625-635. In International Rice Research Institute. 1972. Rice Breeding. Los Banos, Philippines.

2. Aryeetey, A.N. 1970. Rice research in Ghana including weed control. Ghana Agr. Conf. Rice Production Proc. 37-40.

3. Brown, F.B. 1969. Upland rice in Latin America. Int. Rice Comm. Newsletter 18. 1-5.

4. Burrill, L.C. 1973. Crop losses affecting rice in Liberia. Paper presented at Sierra Leone Rice Workshop, 6-8 April 1973. Njala Univ. Coll., Freetown, Sierra Leone.

6. Cates, A.H. 1969. Weed control in dryland and irrigated rice in the tropics. 2nd Asian-Pacific Weed Sci. Soc. Proc. 84-90.

7. Chabrolin, R. 1969. Research on rice growing in French speaking tropical Africa and Madagascar. Agron. Trop. XXIV. 39-50.

8. Chandler, R.F., Jr. 1970. The technology of tropical rice: present state and future development. Paper presented at Rice Research Seminar 16-20 March, 1973. Univ. Ibadan, Ibadan, Nigeria.

9. Dadey, C.A. 1973. Plant protection for the rice crop. Paper presented at WARDA Plant Protection Seminar, 21-29 May 1973. Monrovia, Liberia.

10. De Datta, S.K., Aragon, E.L. and Malabuyo, J.A. 1973. Varietal differences in and cultural practices for upland rice. Paper presented at WARDA Rice Breeding and Varietal Improvement Seminar, 15-20 Jan., 1973, Monrovia, Liberia.

11. De Datta, S.K. and Beachell, H.M. 1972. Varietal responses to some factors affecting production of upland rice. In International Rice Research Institute, 1972. Rice Breeding. Los Banos, Philippines.

12. De Datta, S.K. Sernasor, P.C. and Malabuyo, J.A. 1973. Paper presented at International Rice Research Conference, 23-27 April 1973. Int. Rice Res. Inst. Los Banos, Philippines.

13. Greenland, D.J. 1970. The maintenance of shifting cultivation versus the development of continuous management systems. Paper presented at a seminar on traditional African agricultural systems and their improvement. Univ. of Ibadan, Ibadan, Nigeria. 16-20 November 1970.

14. International Institute of Tropical Agriculture. 1972. 1971 report. Int. Inst. Trop. Agric., Ibadan, Nigeria. 112p.

15. International Institute of Tropical Agriculture. 1973. 1972 report Farming Systems program. Int. Inst. Trop. Agr., Ibadan, Nigeria. 92p.

16. International Institute of Tropical Agriculture. 1974. 1973 report Farming Systems program. Int. Inst. Trop. Agr., Ibadan, Nigeria (in press).

17. Jan, P. 1973. Weed control problems in West African rice cultivation. Paper presented at WARDA Plant protection seminar, 21-29 May 1973.

18. Kawa, S.A., Sawyerr, J.S. and Rhodes, E.R. 1973. Sierra Leone country report. Paper presented at the FAO/SIDA regional seminar on shifting cultivation and soil conservation in Africa. 2-21 July 1973. Univ. Ibadan, Ibadan, Nigeria.

19. Mangunsoekardjo, S. and Kadnan, N. 1971. Weed control in upland rice. 1st Indonesian Weed Sci. Conf. Proc. 133-135.

20. Mayer, J. and Chabrolin, R. 1972. Faut-il rehabiliter le riz pluvial? Techniques et developpement. 1. 34-38.

21. Moigne, M., Le. 1971. Mechanization and small-scale rice farming agricultural communities and motorized operations. Paper presented at a meeting of experts on the mechanization of rice production and processing. 27 September - 2 October, 1971. Paramaribo, Surinam.

22. Moody, K. 1973. Weeds and shifting cultivation. Paper presented at the FAO/SIDA Regional Seminar on Shifting Cultivation and soil conservation in Africa. 2-21 July 1973. Univ. Ibadan, Ibadan, Nigeria.

23. Moomaw, J.C. and Curfs, H.P. 1971. Some general and special aspects of rice soil tillage. Paper presented at a meeting of experts on the mechanization of rice production and processing. 27 September - 2 October, 1971. Paramaribo, Surinam.

24. Muller, G. and Bilderling, G. de. 1953. Les methods culturales indigenes sur les sols equatoriaux de Plateau. I.N.E.A.C. Belg. Bull. Information. 2. 21-30.

25. Nicou, R. and Poulain, J.F. 1971. Agronomic consequences of soil cultivation on dry tropical zone. Paper presented at a seminar on agricultural mechanization in West Africa. 25-29 January, 1971. Bambey, Senegal.

26. Nigeria, Western State. 1973. Approved Farm Practices. Agr. News. 12. 25-27.

27. Parry, G. 1974. Rice production in Ghana. Paper presented at WARDA project managers' meeting, 4-8 February, 1974. Monrovia, Liberia.

28. Patel, N.P. and Rhodes, P.L. 1969. Problems and progress in weed science in Fiji. Fiji Dep. Agr. Bull. 53. 22p.

29. Pyne, C.T. 1973. A review of plant protection of rice in Sierra Leone. Paper presented at Sierra Leone Rice Workshop. April 6-8, 1973. Njala Univ. Coll., Freetown, Sierra Leone.

30. Renaut, G. 1972. Contribution a l'etude du desherbage du riz pluvial en conte d'Ivoire. Agron. Trop XXVII. 221-228.

31 Sanchez, P.A. and Nurena, M.A. 1970. Upland rice improvement under shifting cultivation systems in the Amazon basin of Peru. North Carolina Agr. Exp. Sta. 36p. mimeo.

32. Smith, R.J., Jr. 1969. International cooperative experiments on evaluating herbicides for weed control in rice. Int. Rice Comm. Newsletter 18. 7-20.

33. Sodetidjo, D. and Sjarifullah, G. 1971. The use of propanil and MCPA in upland rice cultivation. 1st Indonesian Weed Sci. Conf. Proc. 129-132.

34. Tiley, G.E.D. 1970. Weeds p. 297-317. In D.J. Parsons (ed.) Agriculture in Uganda, 2nd ed. Oxford Univ. Press.

35. Upton, M. 1967. Agriculture in south-western Nigeria. Dept. Agr. Economics, Development Studies No.3, Univ. Reading, England. 115p.

36. USDA/USAID. 1968. Rice in West Africa. Washington, D.C. 196p.

37. Vega, M.R. 1970. Control of weeds in upland rice. Paper presented at International Rice Research Conference 20-24 April, 1970. Int. Rice Res. Inst., Los Banos, Philippines.

38. Vega, M.R., Ona, J.D. and Paler, E.C. jr. 1967. Weed control in upland rice at the University of the Philippines, College of Agriculture. Philippine Agr. LI. 397-411.

39. Williams, S.K.T. and Alao, J.A. 1972. Evaluation of the rice/maize project of the USAID/Ministry of Agriculture and Natural Resources, Western State, Nigeria. Dep. Ext. Edu. and Rural Sociology, Univ. Ife, Nigeria. 66p.